

rulemaking will be published in the FEDERAL REGISTER.

(c) If the petition is denied, the petitioner will be informed of the grounds.

(d) Commission action on a petition will normally follow, whenever appropriate, receipt and evaluation of Executive Branch views.

(e) The Commission, in exercising the discretion authorized by section 4(a)(1) of the Administrative Procedure Act (5 U.S.C. 553(a)(1)), will decide what, if any, public rulemaking procedures will be followed.

§ 110.133 Notice of proposed rulemaking.

(a) When the Commission proposes to amend the regulations in this part, it will normally publish a notice of proposed rulemaking in the FEDERAL REGISTER.

(b) A notice of proposed rulemaking will include:

(1) The authority for the proposed rule;

(2) The substance and purpose of the proposed rule;

(3) Directions for public participation;

(4) The time and place of any public hearing; and

(5) If a hearing is to be held by other than the Commission, designating of a presiding officer and instructions for the conduct of the hearing.

(c) A notice of proposed rulemaking will be published not less than 15 days before any hearing, unless the Commission for good cause provides otherwise in the notice.

§ 110.134 Public participation.

(a) The Commission may hold an oral hearing on a proposed rule or permit any person to participate in a rulemaking proceeding through the submission of written comments.

(b) When it is in the public interest and is authorized by law, public rulemaking procedures may be omitted and a notice of rulemaking published pursuant to § 110.135.

§ 110.135 Notice of rulemaking.

(a) Upon approval of an amendment, the Commission will publish in the FEDERAL REGISTER a notice of rulemaking which includes a statement of

its basis and purpose, effective date and, where appropriate, any significant variations from the amendment as proposed in any notice of proposed rulemaking.

(b) The effective date of an amendment will normally be no earlier than 30 days after publication of the notice of rulemaking, unless the Commission for good cause provides otherwise in the notice.

APPENDIX A TO PART 110—ILLUSTRATIVE LIST OF NUCLEAR REACTOR EQUIPMENT UNDER NRC EXPORT LICENSING AUTHORITY

NOTE—A nuclear reactor basically includes the items within or attached directly to the reactor vessel, the equipment which controls the level of power in the core, and the components which normally contain or come in direct contact with or control the primary coolant of the reactor core.

(1) Reactor pressure vessels, i.e., metal vessels, as complete units or major shop-fabricated parts, especially designed or prepared to contain the core of a nuclear reactor and capable of withstanding the operating pressure of the primary coolant.

(2) On-line (e.g., CANDU) reactor fuel charging and discharging machines, i.e., manipulative equipment especially designed for inserting or removing fuel in an operating nuclear reactor.

(3) Complete reactor control rod system, i.e., rods especially designed or prepared for the control of the reaction rate in a nuclear reactor, including the neutron absorbing part and the support or suspension structures therefor;

(4) Reactor primary coolant pumps, i.e., pumps especially designed or prepared for circulating the primary coolant in a nuclear reactor.

(5) Reactor pressure tubes, i.e., tubes especially designed or prepared to contain fuel elements and the primary coolant in a nuclear reactor at an operating pressure in excess of 50 atmospheres.

(6) Zirconium tubes, i.e., zirconium metal and alloys in the form of tubes or assemblies of tubes especially designed or prepared for use in a nuclear reactor.

(7) Reactor internals, e.g., core support structures, control and rod guide tubes, thermal shields, baffles, core grid plates and diffuser plates especially designed or prepared for use in a nuclear reactor.

(8) Reactor control rod drive mechanisms, including detection and measuring equipment to determine flux levels.

(9) Any other components especially designed or prepared for use in a nuclear reactor or in any of the components described in this appendix.

[55 FR 30450, July 26, 1990, as amended at 55 FR 34519, Aug. 23, 1990; 58 FR 13004, Mar. 9, 1993; 61 FR 35602, July 8, 1996; 65 FR 70291, Nov. 22, 2000]

APPENDIX B TO PART 110—ILLUSTRATIVE LIST OF GAS CENTRIFUGE ENRICHMENT PLANT COMPONENTS UNDER NRC'S EXPORT LICENSING AUTHORITY

1. *Assemblies and components especially designed or prepared for use in gas centrifuges.*

NOTE: The gas centrifuge normally consists of a thin-walled cylinder(s) of between 75mm (3 ins.) and 400 mm (16 ins.) diameter contained in a vacuum environment and spun at high peripheral speed (of the order of 300 m per second and more) with the central axis vertical. In order to achieve high speed, the materials of construction for the rotating rotor assembly, and hence its individual components, have to be manufactured to very close tolerances in order to minimize the unbalance. In contrast to other centrifuges, the gas centrifuge for uranium enrichment is characterized by having within the rotor chamber a rotating disc-shaped baffle(s) and a stationary tube arrangement for feeding and extracting UF₆ gas and featuring at least 3 separate channels of which 2 are connected to scoops extending from the rotor axis towards the periphery of the rotor chamber. Also contained within the vacuum environment are a number of critical items which do not rotate and which, although they are especially designed, are not difficult to fabricate nor are they fabricated out of unique materials. A centrifuge facility, however, requires a large number of these components so that quantities can provide an important indication of end use.

1.1 *Rotating Components.*

(a) Complete Rotor Assemblies: Thin-walled cylinders, or a number of interconnected thin-walled cylinders, manufactured from one of the high strength-to-density ratio materials described in the Footnote to this Section.

If interconnected, the cylinders are joined together by flexible bellows or rings as described in §1.1(c). The rotor is fitted with an internal baffle(s) and end caps, as described in §1.1 (d) and (e), if in final form. However, the complete assembly may be delivered only partly assembled.

(b) Rotor Tubes: Especially designed or prepared thin-walled cylinders with thickness of 12mm (.50 in.) or less, a diameter of between 75mm (3 ins.) and 400mm (16 ins.), and manufactured from one of the high

strength-to-density ratio materials described in the Footnote to this Section.

(c) Rings or Bellows: Components especially designed or prepared to give localized support to the rotor tube or to join together a number of rotor tubes. The bellows in a short cylinder of wall thickness 3mm (.125 in.) or less, a diameter of between 75mm (3 ins.) and 400mm (16 ins.), having a convolute, and manufactured from one of the high strength-to-density ratio materials described in the footnote to this section.

(d) Baffles: Disc shaped components of between 75mm (3 ins.) and 400mm (16 ins.) diameter especially designed or prepared to be mounted inside the centrifuge rotor tube, in order to isolate the take-off chamber from the main separation chamber and, in some cases, to assist the UF₆ gas circulation within the main separation chamber of the rotor tube, and manufactured from one of the high strength-to-density ratio materials described in the Footnote to this Section.

(e) Top Caps/Bottom Caps: Disc shaped components of between 75mm (3 ins.) and 400mm (16 ins.) diameter especially designed or prepared to fit to the ends of the rotor tube, and so contain the UF₆ within the rotor tube, and in some cases to support, retain or contain as an integrated part, an element of the upper bearing (top cap) or to carry the rotating elements of the motor and lower bearing (bottom cap), and manufactured from one of the high strength-to-density ratio materials described in the Footnote to this Section.

FOOTNOTE

The materials used for centrifuge rotating components are:

(a) Maraging steel capable of an ultimate tensile strength of 2.050×10^9 N/m² (300,000 lb/in.²) or more.

(b) Aluminium alloys capable of an ultimate tensile strength of 0.460×10^9 N/m² (67,000 lb/in.²) or more.

(c) Filamentary materials suitable for use in composite structures and having a specific modulus of 3.18×10^6 m or greater and a specific ultimate tensile strength of 7.62×10^4 m or greater.

("Specific Modulus" is the Young's modulus in N/m² divided by the specific weight in N/m³ when measured at a temperature of 23±20C and a relative humidity of 50±5%. "Specific tensile strength" is the ultimate tensile strength in N/m² divided by the specific weight in N/m³ when measured at a temperature of 23±20C and a relative humidity of 50±5%.)

1.2 *Static Components.*

(a) Magnetic Suspension Bearings: Especially designed or prepared bearing assemblies consisting of an annular magnet suspended within a housing containing a damping medium. The housing will be manufactured from a UF_6 resistant material (see footnote to section 2). The magnet couples with a pole piece or a second magnet fitted to the top cap described in Section 1.1(e). The magnet may be ring-shaped with a relation between outer and inner diameter smaller or equal to 1.6:1. The magnet may be in a form having an initial permeability of 0.15 Henry/meter (120,000 in CGS units) or more, or a remanence of 98.5 percent or more, or an energy product of greater than 80,000 joules/m³ (10×10^6 gauss-oersteds.) In addition to the usual material properties, it is a prerequisite that the deviation of the magnetic axes from the geometrical axes is limited to very small tolerances (lower than 0.1mm) or that homogeneity of the material of the magnet is specially called for.

(b) Bearings/Dampers: Especially designed or prepared bearings comprising a pivot/cup assembly mounted on a damper. The pivot is normally a hardened steel shaft polished into a hemisphere at one end with a means of attachment to the bottom cap described in Section 1.1(e) at the other. The shaft may, however, have a hydrodynamic bearing attached. The cup is pellet-shaped with hemispherical indentation in one surface. These components are often supplied separately to the damper.

(c) Molecular Pumps: Especially designed or prepared cylinders having internally machined or extruded helical grooves and internally machined bores. Typical dimensions are as follows: 7mm (0.3 ins.) to 400mm (16 ins.) internal diameter, 10mm (0.4 ins.) or more wall thickness, 1 to 1 length to diameter ratio. The grooves are typically rectangular in cross-section and 2mm (0.08 in.) or more in depth.

(d) Motor Stators: Especially designed or prepared ring shaped stators for high speed multi-phase AC hysteresis (or reluctance) motors for synchronous operation within a vacuum in the frequency range of 600–2000 Hz and a power range of 50–1000 volts amps. The stators consist of multi-phase windings on a laminated low loss iron core comprised of thin layers typically 2.0mm (0.08 in.) thick or less.

(e) Centrifuge housing/recipients: Components especially designed or prepared to contain the rotor tube assembly of a gas centrifuge. The housing consists of a rigid cylinder of wall thickness up to 30 mm (1.2in) with precision machined ends to locate the bearings and with one or more flanges for mounting. The machined ends are parallel to each other and perpendicular to the cylinder's longitudinal axis to within 0.05 degrees or less. The housing may also be a honeycomb type structure to accommodate sev-

eral rotor tubes. The housings are made of or protected by materials resistant to corrosion by UF_6 .

(f) Scoops: Especially designed or prepared tubes of up to 12 mm (0.5in) internal diameter for the extraction of UF_6 gas from within the rotor tube by a Pitot tube action (that is, with an aperture facing into the circumferential gas flow within the rotor tube, for example by bending the end of a radially disposed tube) and capable of being fixed to the central gas extraction system. The tubes are made of or protected by materials resistant to corrosion by UF_6 .

2. *Especially designed or prepared auxiliary systems, equipment and components for gas centrifuge enrichment plants.*

NOTE: The auxiliary systems, equipment and components for a gas centrifuge enrichment plant are the systems of the plant needed to feed UF_6 to the centrifuges to link the individual centrifuges to each other to form cascades (or stages) to allow for progressively higher enrichments and to extract the product and tails of UF_6 from the centrifuges, together with the equipment required to drive the centrifuges or to control the plant.

Normally UF_6 is evaporated from the solid using heated autoclaves and is distributed in gaseous form to the centrifuges by way of cascade header pipework. The "product" and "tails" of UF_6 gaseous streams flowing from the centrifuges are also passed by way of cascade header pipework to cold traps (operating at about $-70^\circ C$) where they are condensed prior to onward transfer into suitable containers for transportation or storage. Because an enrichment plant consists of many thousands of centrifuges arranged in cascades, there are many kilometers of cascade header pipework incorporating thousands of welds with a substantial amount of repetition of layout. The equipment, component and piping systems are fabricated to very high vacuum and cleanliness standards.

The following items either come into direct contact with UF_6 process gas or directly control the centrifuge and the passage of the gas from centrifuge to centrifuge and cascade to cascade.

(a) Feed Systems/Product and Tails Withdrawal Systems:

Especially designed or prepared process systems including:

1. Feed autoclaves (or stations), used for passing UF_6 to the centrifuge cascades at up to 100 kN/m² (15 psi) and at a rate of 1 kg/h or more.

2. Desublimers (or cold traps) used to remove UF_6 from the cascades at up to 3 kN/m² (0.5 lb/in²) pressure. The desublimers are capable of being chilled to $-70^\circ C$ and heated to $70^\circ C$.

3. Product and tails stations used for trapping UF_6 into containers.

This plant equipment and pipework are wholly made of or lined with UF₆ resistant materials (see Footnote to this Section) and are fabricated to very high vacuum and cleanliness standards.

(b) Machine Header Piping Systems:

Especially designed or prepared piping systems and header systems for handling UF₆ within the centrifuge cascades.

This piping network is normally of the "triple" header system with each centrifuge connected to each of the headers. There is thus a substantial amount of repetition in its form. It is wholly made of UF₆ resistant materials (see Note to this Section) and is fabricated to very high vacuum and cleanliness standards.

(c) UF₆ Mass Spectrometers/Ion Sources: Especially designed or prepared magnetic or quadrupole mass spectrometers capable of taking "on-line" sample of feed, product or tails from UF₆ gas streams and having all of the following characteristics:

1. Unit resolution for mass greater than 320.
2. Ion sources constructed of or lined with nichrome, monel or nickel-plate.
3. Electron bombardment ionization sources.
4. Having a collector system suitable for isotope analysis.

(d) Frequency Changers: Frequency changers (also known as converters or invertors) especially designed or prepared to supply motor stators as defined under Section 1.2(d), or parts, components and subassemblies of such frequency changers having all of the following characteristics:

1. A multiphase output of 600 Hz to 2000Hz.
2. High stability (with frequency control better than 0.1%).
3. Low harmonic distortion (less than 2%).
4. An efficiency of greater than 80%.

FOOTNOTE

Materials resistant to corrosion by UF₆ include stainless steel, aluminum, aluminum alloys, nickel or alloys containing 60% or more nickel.

[49 FR 47203, Dec. 3, 1984. Redesignated at 55 FR 30450, July 26, 1990; 58 FR 13005, Mar. 9, 1993; 61 FR 35602, July 8, 1996; 65 FR 70291, Nov. 22, 2000]

APPENDIX C TO PART 110—ILLUSTRATIVE LIST OF GASEOUS DIFFUSION ENRICHMENT PLANT ASSEMBLIES AND COMPONENTS UNDER NRC EXPORT LICENSING AUTHORITY

NOTE—In the gaseous diffusion method of uranium isotope separation, the main technological assembly is a special porous gaseous diffusion barrier, heat exchanger for cooling the gas (which is heated by the process of compression), seal valves and control

valves, and pipelines. Inasmuch as gaseous diffusion technology uses uranium hexafluoride (UF₆), all equipment, pipeline and instrumentation surfaces (that come in contact with the gas) must be made of materials that remain stable in contact with UF₆. A gaseous diffusion facility requires a number of these assemblies, so that quantities can provide an important indication of end use.

The auxiliary systems, equipment and components for gaseous diffusion enrichment plants are the systems of plant needed to feed UF₆ to the gaseous diffusion assembly to link the individual assemblies to each other to form cascades (or stages) to allow for progressively higher enrichments and to extract the "product" and "tails" UF₆ from the diffusion cascades. Because of the high inertial properties of diffusion cascades, any interruption in their operation, and especially their shut-down, leads to serious consequences. Therefore, a strict and constant maintenance of vacuum in all technological systems, automatic protection for accidents, and precise automated regulation of the gas flow is of importance in a gaseous diffusion plant. All this leads to a need to equip the plant with a large number of special measuring, regulating, and controlling systems.

Normally UF₆ is evaporated from cylinders placed within autoclaves and is distributed in gaseous form to the entry point by way of cascade header pipework. The "product" and "tails" UF₆ gaseous streams flowing from exit points are passed by way of cascade header pipework to either cold traps or to compression stations where the UF₆ gas is liquified prior to onward transfer into suitable containers for transportation or storage. Because a gaseous diffusion enrichment plant consists of a large number of gaseous diffusion assemblies arranged in cascades, there are many kilometers of cascade header pipework, incorporating thousands of welds with substantial amounts of repetition of layout. The equipment, components and piping systems are fabricated to very high vacuum and cleanliness standards.

The items listed below either come into direct contact with the UF₆ process gas or directly control the flow within the cascade. All surfaces which come into contact with the process gas are wholly made of, or lined with, UF₆-resistant materials. For the purposes of this appendix the materials resistant to corrosion by UF₆ include stainless steel, aluminum, aluminum alloys, aluminum oxide, nickel or alloys containing 60 percent or more nickel, and UF₆-resistant fully fluorinated hydrocarbon polymers.

1. Assemblies and components especially designed or prepared for use in gaseous diffusion enrichment.

1.1 Gaseous Diffusion Barriers

Especially designed or prepared thin, porous filters, with a pore size of 100–1000 Å (angstroms), a thickness of 5 mm or less, and for tubular forms, a diameter of 25 mm or less, made of metallic, polymer or ceramic materials resistant to corrosion by UF_6 , and especially prepared compounds or powders for the manufacture of such filters. Such compounds and powders include nickel or alloys containing 60 percent or more nickel, aluminum oxide, or UF_6 -resistant fully fluorinated hydrocarbon polymers having a purity of 99.9 percent or more, a particle size less than 10 microns, and a high degree of particle size uniformity, which are especially prepared for the manufacture of gaseous diffusion barriers.

1.2 Diffuser Housings

Especially designed or prepared hermetically sealed cylindrical vessels greater than 30 cm in diameter and greater than 90 cm in length, or rectangular vessels of comparable dimensions, which have an inlet connection and two outlet connections all of which are greater than 5 cm in diameter, for containing the gaseous diffusion barrier, made of or lined with UF_6 -resistant materials and designed for horizontal or vertical installation.

1.3 Compressors and Gas Blowers

Especially designed or prepared axial, centrifugal, or positive displacement compressors, or gas blowers with a suction volume capacity of 1 m^3/min or more of UF_6 , and with a discharge pressure of up to several hundred kN/m^2 (100 PSI), designed for long-term operation in the UF_6 environment with or without an electrical motor of appropriate power, as well as separate assemblies of such compressors and gas blowers. These compressors and gas blowers have a pressure ratio between 2/1 and 6/1 and are made of, or lined with, materials resistant to UF_6 .

1.4 Rotary Shaft Seals

Especially designed or prepared vacuum seals, with seal feed and seal exhaust connections, for sealing the shaft connecting the compressor or the gas blower rotor with the driver motor so as to ensure a reliable seal against in-leaking of air into the inner chamber of the compressor or gas blower which is filled with UF_6 . Such seals are normally designed for a buffer gas in-leakage rate of less than 1000 cm^3/min .

1.5 Heat Exchangers for Cooling UF_6

Especially designed or prepared heat exchangers made of or lined with UF_6 resistant materials (except stainless steel) or with copper or any combination of those metals, and intended for a leakage pressure change

rate of less than 10 N/m^2 (0.0015 PSI) per hour under a pressure difference of 100 kN/m^2 (15 PSI).

2. Auxiliary systems, equipment and components especially designed or prepared for use in gaseous diffusion enrichment.

2.1 Feed Systems/Product and Tails Withdrawal Systems

Especially designed or prepared process systems, capable of operating at pressures of 300 kN/m^2 (45 PSI) or less, including:

1. Feed autoclaves (or systems), used for passing UF_6 to the gaseous diffusion cascades;
2. Desublimers (or cold traps) used to remove UF_6 from diffusion cascades;
3. Liquefaction stations where UF_6 gas from the cascade is compressed and cooled to form liquid UF_6 ;
4. "Product" or "tails" stations used for transferring UF_6 into containers.

2.2 Header Piping Systems

Especially designed or prepared piping systems and header systems for handling UF_6 within the gaseous diffusion cascades. This piping network is normally of the "double" header system with each cell connected to each of the headers.

2.3 Vacuum Systems

- (a) Especially designed or prepared large vacuum manifolds, vacuum headers and vacuum pumps having a suction capacity of 5 m^3/min or more.
- (b) Vacuum pumps especially designed for service in UF_6 -bearing atmospheres made of, or lined with, aluminum, nickel, or alloys bearing more than 60 percent nickel. These pumps may be either rotary or positive displacement, may have fluorocarbon seals, and may have special working fluids present.

2.4 Special Shut-Off and Control Valves

Especially designed or prepared manual or automated shut-off and control bellows valves made of UF_6 resistant materials with a diameter of 4 cm to 1.5 m for installation in main and auxiliary systems of gaseous diffusion enrichment plants.

2.5 UF_6 Mass Spectrometers/Ion Sources

Especially designed or prepared magnetic or quadrupole mass spectrometers capable of taking "on-line" samples of feed, product or tails, from UF_6 gas streams and having all of the following characteristics:

- (a) unit resolution for mass greater than 320;
- (b) ion sources constructed of or lined with nichrome or monel or nickel plated;
- (c) electron bombardment ionization sources;

(d) having a collector system suitable for isotopic analysis.

[55 FR 30451, July 26, 1990]

APPENDIX D TO PART 110—ILLUSTRATIVE
LIST OF AERODYNAMIC ENRICHMENT
PLANT EQUIPMENT AND COMPONENTS
UNDER NRC EXPORT LICENSING AU-
THORITY

NOTE—In aerodynamic enrichment processes, a mixture of gaseous UF₆ and light gas (hydrogen or helium) is compressed and then passed through separating elements wherein isotopic separation is accomplished by the generation of high centrifugal forces over a curved-wall geometry. Two processes of this type have been successfully developed: the separation nozzle process and the vortex tube process. For both processes the main components of a separation stage included cylindrical vessels housing the special separation elements (nozzles or vortex tubes), gas compressors and heat exchangers to remove the heat of compression. An aerodynamic plant requires a number of these stages, so that quantities can provide an important indication of end use. Because aerodynamic processes use UF₆, all equipment, pipeline and instrumentation surfaces (that come in contact with the gas) must be made of materials that remain stable in contact with UF₆. All surfaces which come into contact with the process gas are made of or protected by UF₆-resistant materials; including copper, stainless steel, aluminum, aluminum alloys, nickel or alloys containing 60% or more nickel and UF₆-resistant fully fluorinated hydrocarbon polymers.

The following items either come into direct contact with the UF₆ process gas or directly control the flow within the cascade:

(1) Separation nozzles and assemblies.

Especially designed or prepared nozzles that consist of slit-shaped, curved channels having a radius of curvature less than 1 mm (typically 0.1 to 0.05 mm). The nozzles are resistant to UF₆ corrosion and have a knife-edge within the nozzle that separates the gas flowing through the nozzle into two fractions.

(2) Vortex tubes and assemblies.

Especially designed or prepared vortex tubes that are cylindrical or tapered, made of or protected by materials resistant to UF₆ corrosion, have a diameter of between 0.5 cm and 4 cm, a length to diameter ratio of 20:1 or less and with one or more tangential inlets. The tubes may be equipped with nozzle-type appendages at either or both ends.

The feed gas enters the vortex tube tangentially at one end or through swirl vanes or at numerous tangential positions along the periphery of the tube.

(3) Compressors and gas blowers.

Especially designed or prepared axial, centrifugal, or positive displacement compressors or gas blowers made of or protected by materials resistant to UF₆ corrosion and with a suction volume capacity of 2 m³/min or more of UF₆/carrier gas (hydrogen or helium) mixture. These compressors and gas blowers typically have a pressure ratio between 1.2:1 and 6:1.

(4) Rotary shaft seals.

Especially designed or prepared seals, with seal feed and seal exhaust connections, for sealing the shaft connecting the compressor rotor or the gas blower rotor with the driver motor to ensure a reliable seal against out-leakage of process gas or in-leakage of air or seal gas into the inner chamber of the compressor or gas blower which is filled with a UF₆/carrier gas mixture.

(5) Heat exchangers for gas cooling.

Especially designed or prepared heat exchangers, made of or protected by materials resistant to UF₆ corrosion.

(6) Separation element housings.

Especially designed or prepared separation element housings, made of or protected by materials resistant to UF₆ corrosion, for containing vortex tubes or separation nozzles.

These housings may be cylindrical vessels greater than 300 mm in diameter and greater than 900 mm in length, or may be rectangular vessels of comparable dimensions, and may be designed for horizontal or vertical installation.

(7) Feed systems/product and tails withdrawal systems.

Especially designed or prepared process systems or equipment for enrichment plants made of or protected by materials resistant to UF₆ corrosion, including:

(i) Feed autoclaves, ovens, or systems used for passing UF₆ to the enrichment process;

(ii) Desublimers (or cold traps) used to remove UF₆ from the enrichment process for subsequent transfer upon heating;

(iii) Solidification or liquefaction stations used to remove UF₆ from the enrichment process by compressing and converting UF₆ to a liquid or solid form; and

(iv) "Product" or "tails" stations used for transferring UF₆ into containers.

(8) Header piping systems.

Especially designed or prepared header piping systems, made of or protected by materials resistant to UF₆ corrosion, for handling UF₆ within the aerodynamic cascades.

The piping network is normally of the "double" header design with each stage or group of stages connected to each of the headers.

(9) Vacuum systems and pumps.

Especially designed or prepared vacuum systems having a suction capacity of 5 m³/min or more, consisting of vacuum manifolds, vacuum headers and vacuum pumps,

and designed for service in UF₆-bearing atmospheres.

Especially designed or prepared vacuum pumps for service in UF₆-bearing atmospheres and made of or protected by materials resistant to UF₆ corrosion. These pumps may use fluorocarbon seals and special working fluids.

(10) Special shut-off and control valves.

Especially designed or prepared manual or automated shut-off and control bellows valves made of or protected by materials resistant to UF₆ corrosion with a diameter of 40 to 1500 mm for installation in main and auxiliary systems of aerodynamic enrichment plants.

(11) UF₆ mass spectrometers/ion sources.

Especially designed or prepared magnetic or quadrupole mass spectrometers capable of taking "on-line" samples of feed, "product" or "tails", from UF₆ gas streams and having all of the following characteristics:

(i) Unit resolution for mass greater than 320;

(ii) Ion sources constructed of or lined with nichrome or monel or nickel plated;

(iii) Electron bombardment ionization sources; and

(iv) Collector system suitable for isotopic analysis.

(12) UF₆/carrier gas separation systems.

Especially designed or prepared process systems for separating UF₆ from carrier gas (hydrogen or helium).

These systems are designed to reduce the UF₆ content in the carrier gas to 1 ppm or less and may incorporate equipment such as:

(i) Cryogenic heat exchangers and cryoseparators capable of temperatures of -120°C or less;

(ii) Cryogenic refrigeration units capable of temperatures of -120°C or less;

(iii) Separation nozzle or vortex tube units for the separation of UF₆ from carrier gas; or

(iv) UF₆ cold traps capable of temperatures of -20°C or less.

[61 FR 35603, July 8, 1996]

APPENDIX E TO PART 110—ILLUSTRATIVE LIST OF CHEMICAL EXCHANGE OR ION EXCHANGE ENRICHMENT PLANT EQUIPMENT AND COMPONENTS UNDER NRC EXPORT LICENSING AUTHORITY

NOTE—The slight difference in mass between the isotopes of uranium causes small changes in chemical reaction equilibria that can be used as a basis for separation of the isotopes. Two processes have been successfully developed: liquid-liquid chemical exchange and solid-liquid ion exchange.

A. In the liquid-liquid chemical exchange process, immiscible liquid phases (aqueous and organic) are countercurrently contacted to give the cascading effect of thousands of separation stages. The aqueous phase con-

sists of uranium chloride in hydrochloric acid solution; the organic phase consists of an extractant containing uranium chloride in an organic solvent. The contactors employed in the separation cascade can be liquid-liquid exchange columns (such as pulsed columns with sieve plates) or liquid centrifugal contactors. Chemical conversions (oxidation and reduction) are required at both ends of the separation cascade in order to provide for the reflux requirements at each end. A major design concern is to avoid contamination of the process streams with certain metal ions. Plastic, plastic-lined (including use of fluorocarbon polymers) and/or glass-lined columns and piping are therefore used.

(1) Liquid-liquid exchange columns.

Countercurrent liquid-liquid exchange columns having mechanical power input (i.e., pulsed columns with sieve plates, reciprocating plate columns, and columns with internal turbine mixers), especially designed or prepared for uranium enrichment using the chemical exchange process. For corrosion resistance to concentrated hydrochloric acid solutions, these columns and their internals are made of or protected by suitable plastic materials (such as fluorocarbon polymers) or glass. The stage residence time of the columns is designed to be short (30 seconds or less).

(2) Liquid-liquid centrifugal contactors.

Especially designed or prepared for uranium enrichment using the chemical exchange process. These contactors use rotation to achieve dispersion of the organic and aqueous streams and then centrifugal force to separate the phases. For corrosion resistance to concentrated hydrochloric acid solutions, the contactors are made of or are lined with suitable plastic materials (such as fluorocarbon polymers) or are lined with glass. The stage residence time of the centrifugal contactors is designed to be short (30 seconds or less).

(3) Uranium reduction systems and equipment.

(i) Especially designed or prepared electrochemical reduction cells to reduce uranium from one valence state to another for uranium enrichment using the chemical exchange process. The cell materials in contact with process solutions must be corrosion resistant to concentrated hydrochloric acid solutions.

The cell cathodic compartment must be designed to prevent re-oxidation of uranium to its higher valence state. To keep the uranium in the cathodic compartment, the cell may have an impervious diaphragm membrane constructed of special cation exchange material. The cathode consists of a suitable solid conductor such as graphite.

These systems consist of solvent extraction equipment for stripping the U+4 from the organic stream into an aqueous solution,

evaporation and/or other equipment to accomplish solution pH adjustment and control, and pumps or other transfer devices for feeding to the electrochemical reduction cells. A major design concern is to avoid contamination of the aqueous stream with certain metal ions. For those parts in contact with the process stream, the system is constructed of equipment made of or protected by materials such as glass, fluorocarbon polymers, polyphenyl sulfate, polyether sulfone, and resin-impregnated graphite.

(ii) Especially designed or prepared systems at the product end of the cascade for taking the U+4 out of the organic stream, adjusting the acid concentration and feeding to the electrochemical reduction cells.

These systems consist of solvent extraction equipment for stripping the U+4 from the organic stream into an aqueous solution, evaporation and/or other equipment to accomplish solution pH adjustment and control, and pumps or other transfer devices for feeding to the electrochemical reduction cells. A major design concern is to avoid contamination of the aqueous stream with certain metal ions. For those parts in contact with the process stream, the system is constructed of equipment made of or protected by materials such as glass, fluorocarbon polymers, polyphenyl sulfate, polyether sulfone, and resin-impregnated graphite.

(4) Feed preparation systems.

Especially designed or prepared systems for producing high-purity uranium chloride feed solutions for chemical exchange uranium isotope separation plants.

These systems consist of dissolution, solvent extraction and/or ion exchange equipment for purification and electrolytic cells for reducing the uranium U+6 or U+4 to U+3. These systems produce uranium chloride solutions having only a few parts per million of metallic impurities such as chromium, iron, vanadium, molybdenum and other bivalent or higher multi-valent cations. Materials of construction for portions of the system processing high-purity U+3 include glass, fluorocarbon polymers, polyphenyl sulfate or polyether sulfone plastic-lined and resin-impregnated graphite.

(5) Uranium oxidation systems.

Especially designed or prepared systems for oxidation of U+3 to U+4 for return to the uranium isotope separation cascade in the chemical exchange enrichment process.

These systems may incorporate equipment such as:

(i) Equipment for contacting chlorine and oxygen with the aqueous effluent from the isotope separation equipment and extracting the resultant U+4 into the stripped organic stream returning from the product end of the cascade; and

(ii) Equipment that separates water from hydrochloric acid so that the water and the concentrated hydrochloric acid may be re-

introduced to the process at the proper locations.

B. In the solid-liquid ion-exchange process, enrichment is accomplished by uranium adsorption/desorption on a special, fast-acting, ion-exchange resin or adsorbent. A solution of uranium in hydrochloric acid and other chemical agents is passed through cylindrical enrichment columns containing packed beds of the adsorbent. For a continuous process, a reflux system is necessary to release the uranium from the adsorbent back in the liquid flow so that "product" and "tails" can be collected. This is accomplished with the use of suitable reduction/oxidation chemical agents that are fully regenerated in separate external circuits and that may be partially regenerated within the isotopic separation columns themselves. The presence of hot concentrated hydrochloric acid solutions in the process requires that the equipment be made of or protected by special corrosion-resistant materials.

(1) Fast reacting ion exchange resins/adsorbents.

Especially designed or prepared for uranium enrichment using the ion exchange process, including porous macroreticular resins, and/or pellicular structures in which the active chemical exchange groups are limited to a coating on the surface of an inactive porous support structure, and other composite structures in any suitable form including particles or fibers. These ion exchange resins/adsorbents have diameters of 0.2 mm or less and must be chemically resistant to concentrated hydrochloric acid solutions as well as physically strong enough so as not to degrade in the exchange columns. The resins/adsorbents are especially designed to achieve very fast uranium isotope exchange kinetics (exchange rate half-time of less than 10 seconds) and are capable of operating at a temperature in the range of 100°C to 200°C.

(2) Ion exchange columns.

Cylindrical columns greater than 1000 mm in diameter for containing and supporting packed beds of ion exchange resin/adsorbent, especially designed or prepared for uranium enrichment using the ion exchange process. These columns are made of or protected by materials (such as titanium or fluorocarbon plastics) resistant to corrosion by concentrated hydrochloric acid solutions and are capable of operating at a temperature in the range of 100°C to 200°C and pressures above 0.7 MPa (102 psia).

(3) Ion exchange reflux systems.

(i) Especially designed or prepared chemical or electrochemical reduction systems for regeneration of the chemical reducing agent(s) used in ion exchange uranium enrichment cascades.

The ion exchange enrichment process may use, for example, trivalent titanium (Ti+3) as

a reducing cation in which case the reduction system would regenerate $Ti+3$ by reducing $Ti+4$.

(ii) Especially designed or prepared chemical or electrochemical oxidation systems for regeneration of the chemical oxidizing agent(s) used in ion exchange uranium enrichment cascades.

The ion exchange enrichment process may use, for example, trivalent iron ($Fe+3$) as an oxidant in which case the oxidation system would regenerate $Fe+3$ by oxidizing $Fe+2$.

[61 FR 35604, July 8, 1996]

APPENDIX F TO PART 110—ILLUSTRATIVE LIST OF LASER-BASED ENRICHMENT PLANT EQUIPMENT AND COMPONENTS UNDER NRC EXPORT LICENSING AUTHORITY

NOTE—Present systems for enrichment processes using lasers fall into two categories: the process medium is atomic uranium vapor and the process medium is the vapor of a uranium compound. Common nomenclature for these processes include: first category-atomic vapor laser isotope separation (AVLIS or SILVA); second category-molecular laser isotope separation (MLIS or MOLIS) and chemical reaction by isotope selective laser activation (CRISLA). The systems, equipment and components for laser enrichment plants include: (a) Devices to feed uranium-metal vapor for selective photo-ionization or devices to feed the vapor of a uranium compound for photo-dissociation or chemical activation; (b) devices to collect enriched and depleted uranium metal as "product" and "tails" in the first category, and devices to collect dissociated or reacted compounds as "product" and unaffected material as "tails" in the second category; (c) process laser systems to selectively excite the uranium-235 species; and (d) feed preparation and product conversion equipment. The complexity of the spectroscopy of uranium atoms and compounds may require incorporation of a number of available laser technologies.

All surfaces that come into contact with the uranium or UF_6 are wholly made of or protected by corrosion-resistant materials. For laser-based enrichment items, the materials resistant to corrosion by the vapor or liquid of uranium metal or uranium alloys include yttria-coated graphite and tantalum; and the materials resistant to corrosion by UF_6 include copper, stainless steel, aluminum, aluminum alloys, nickel or alloys containing 60% or more nickel and UF_6 -resistant fully fluorinated hydrocarbon polymers.

Many of the following items come into direct contact with uranium metal vapor or liquid or with process gas consisting of UF_6 or a mixture of UF_6 and other gases:

(1) Uranium vaporization systems (AVLIS).

Especially designed or prepared uranium vaporization systems that contain high-power strip or scanning electron beam guns with a delivered power on the target of more than 2.5 kW/cm.

(2) Liquid uranium metal handling systems (AVLIS).

Especially designed or prepared liquid metal handling systems for molten uranium or uranium alloys, consisting of crucibles and cooling equipment for the crucibles.

The crucibles and other system parts that come into contact with molten uranium or uranium alloys are made of or protected by materials of suitable corrosion and heat resistance, such as tantalum, yttria-coated graphite, graphite coated with other rare earth oxides or mixtures thereof.

(3) Uranium metal "product" and "tails" collector assemblies (AVLIS).

Especially designed or prepared "product" and "tails" collector assemblies for uranium metal in liquid or solid form.

Components for these assemblies are made of or protected by materials resistant to the heat and corrosion of uranium metal vapor or liquid, such as yttria-coated graphite or tantalum, and may include pipes, valves, fittings, "gutters", feed-throughs, heat exchangers and collector plates for magnetic, electrostatic or other separation methods.

(4) Separator module housings (AVLIS).

Especially designed or prepared cylindrical or rectangular vessels for containing the uranium metal vapor source, the electron beam gun, and the "product" and "tails" collectors.

These housings have multiplicity of ports for electrical and water feed-throughs, laser beam windows, vacuum pump connections and instrumentation diagnostics and monitoring with opening and closure provisions to allow refurbishment of internal components.

(5) Supersonic expansion nozzles (MLIS).

Especially designed or prepared supersonic expansion nozzles for cooling mixtures of UF_6 and carrier gas to 150 K or less which are corrosion resistant to UF_6 .

(6) Uranium pentafluoride product collectors (MLIS).

Especially designed or prepared uranium pentafluoride (UF_5) solid product collectors consisting of filter, impact, or cyclone-type collectors, or combinations thereof, which are corrosion resistant to the UF_5/UF_6 environment.

(7) UF_6 /carrier gas compressors (MLIS).

Especially designed or prepared compressors for UF_6 /carrier gas mixtures, designed for long term operation in a UF_6 environment. Components of these compressors that come into contact with process gas are made of or protected by materials resistant to UF_6 corrosion.

(8) Rotary shaft seals (MLIS).

Especially designed or prepared rotary shaft seals, with seal feed and seal exhaust connections, for sealing the shaft connecting the compressor rotor with the driver motor to ensure a reliable seal against out-leakage of process gas or in-leakage of air or seal gas into the inner chamber of the compressor which is filled with a UF₆/carrier gas mixture.

(9) Fluorination systems (MLIS).

Especially designed or prepared systems for fluorinating UF₅ (solid) to UF₆ (gas).

These systems are designed to fluorinate the collected UF₅ powder to UF₆ for subsequent collection in product containers or for transfer as feed to MLIS units for additional enrichment. In one approach, the fluorination reaction may be accomplished within the isotope separation system to react and recover directly off the "product" collectors. In another approach, the UF₅ powder may be removed/transferred from the "product" collectors into a suitable reaction vessel (e.g., fluidized-bed reactor, screw reactor or flame tower) for fluorination. In both approaches equipment is used for storage and transfer of fluorine (or other suitable fluorinating agents) and for collection and transfer of UF₆.

(10) UF₆ mass spectrometers/ion sources (MLIS).

Especially designed or prepared magnetic or quadrupole mass spectrometers capable of taking "on-line" samples of feed, "product" or "tails", from UF₆ gas streams and having all of the following characteristics:

- (i) Unit resolution for mass greater than 320;
- (ii) Ion sources constructed of or lined with nichrome or monel or nickel plated;
- (iii) Electron bombardment ionization sources; and
- (iv) Collector system suitable for isotopic analysis.

(11) Feed systems/product and tails withdrawal systems (MLIS).

Especially designed or prepared process systems or equipment for enrichment plants made of or protected by materials resistant to corrosion by UF₆, including:

- (i) Feed autoclaves, ovens, or systems used for passing UF₆ to the enrichment process;
- (ii) Desublimers (or cold traps) used to remove UF₆ from the enrichment process for subsequent transfer upon heating;
- (iii) Solidification or liquefaction stations used to remove UF₆ from the enrichment process by compressing and converting UF₆ to a liquid or solid; and
- (iv) "Product" or "tails" stations used to transfer UF₆ into containers.

(12) UF₆/carrier gas separation systems (MLIS).

Especially designed or prepared process systems for separating UF₆ from carrier gas. The carrier gas may be nitrogen, argon, or other gas.

These systems may incorporate equipment such as:

- (i) Cryogenic heat exchangers or cryoseparators capable of temperatures of -120°C or less;
 - (ii) Cryogenic refrigeration units capable of temperatures of -120°C or less; or
 - (iii) UF₆ cold traps capable of temperatures of -20°C or less.
- (13) Lasers or Laser systems (AVLIS, MLIS and CRISLA).

Especially designed or prepared for the separation of uranium isotopes. The laser system for the AVLIS process usually consists of two lasers: a copper vapor laser and a dye laser. The laser system for MLIS usually consists of a CO₂ or excimer laser and a multi-pass optical cell with revolving mirrors at both ends. Lasers or laser systems for both processes require a spectrum frequency stabilizer for operation over extended periods.

[61 FR 35605, July 8, 1996]

APPENDIX G TO PART 110—ILLUSTRATIVE LIST OF PLASMA SEPARATION ENRICHMENT PLANT EQUIPMENT AND COMPONENTS UNDER NRC EXPORT LICENSING AUTHORITY

NOTE—In the plasma separation process, a plasma of uranium ions passes through an electric field tuned to the ²³⁵U ion resonance frequency so that they preferentially absorb energy and increase the diameter of their corkscrew-like orbits. Ions with a large-diameter path are trapped to produce a product enriched in ²³⁵U. The plasma, made by ionizing uranium vapor, is contained in a vacuum chamber with a high-strength magnetic field produced by a superconducting magnet. The main technological systems of the process include the uranium plasma generation system, the separator module with superconducting magnet, and metal removal systems for the collection of "product" and "tails".

(1) Microwave power sources and antennae.

Especially designed or prepared microwave power sources and antennae for producing or accelerating ions having the following characteristics: greater than 30 GHz frequency and greater than 50 kW mean power output for ion production.

(2) Ion excitation coils.

Especially designed or prepared radio frequency ion excitation coils for frequencies of more than 100 kHz and capable of handling more than 40 kW mean power.

(3) Uranium plasma generation systems.

Especially designed or prepared systems for the generation of uranium plasma, which may contain high power strip or scanning electron beam guns with a delivered power on the target of more than 2.5 kW/cm.

(4) Liquid uranium metal handling systems.

Especially designed or prepared liquid metal handling systems for molten uranium or uranium alloys, consisting of crucible and cooling equipment for the crucibles.

The crucibles and other system parts that come into contact with molten uranium or uranium alloys are made of or protected by corrosion and heat resistance materials, such as tantalum, yttria-coated graphite, graphite coated with other rare earth oxides or mixtures thereof.

(5) Uranium metal "product" and "tails" collector assemblies.

Especially designed or prepared "product" and "tails" collector assemblies for uranium metal in solid form. These collector assemblies are made of or protected by materials resistant to the heat and corrosion of uranium metal vapor, such as yttria-coated graphite or tantalum.

(6) Separator module housings.

Especially designed or prepared cylindrical vessels for use in plasma separation enrichment plants for containing the uranium plasma source, radio-frequency drive coil and the "product" and "tails" collectors.

These housings have a multiplicity of ports for electrical feed-throughs, diffusion pump connections and instrumentation diagnostics and monitoring. They have provisions for opening and closure to allow for refurbishment of internal components and are constructed of a suitable non-magnetic material such as stainless steel.

[61 FR 35606, July 8, 1996]

APPENDIX H TO PART 110—ILLUSTRATIVE LIST OF ELECTROMAGNETIC ENRICHMENT PLANT EQUIPMENT AND COMPONENTS UNDER NRC EXPORT LICENSING AUTHORITY

NOTE—In the electromagnetic process, uranium metal ions produced by ionization of a salt feed material (typically UCL4) are accelerated and passed through a magnetic field that has the effect of causing the ions of different isotopes to follow different paths. The major components of an electromagnetic isotope separator include: a magnetic field for ion-beam diversion/separation of the isotopes, an ion source with its acceleration system, and a collection system for the separated ions. Auxiliary systems for the process include the magnet power supply system, the ion source high-voltage power supply system, the vacuum system, and extensive chemical handling systems for recovery of product and cleaning/recycling of components.

(1) Electromagnetic isotope separators.

Especially designed or prepared for the separation of uranium isotopes, and equipment and components therefor, including:

(i) Ion Sources—especially designed or prepared single or multiple uranium ion sources consisting of a vapor source, ionizer, and beam accelerator, constructed of materials such as graphite, stainless steel, or copper, and capable of providing a total ion beam current of 50 mA or greater;

(ii) Ion collectors—collector plates consisting of two or more slits and pockets especially designed or prepared for collection of enriched and depleted uranium ion beams and constructed of materials such as graphite or stainless steel;

(iii) Vacuum housings—especially designed or prepared vacuum housings for uranium electromagnetic separators, constructed of suitable non-magnetic materials such as stainless steel and designed for operation at pressures of 0.1 Pa or lower.

The housings are specially designed to contain the ion sources, collector plates and water-cooled liners and have provision for diffusion pump connections and opening and closure for removal and reinstallation of these components; and

(iv) Magnet pole pieces—especially designed or prepared magnet pole pieces having a diameter greater than 2 m used to maintain a constant magnetic field within an electromagnetic isotope separator and to transfer the magnetic field between adjoining separators.

(2) High voltage power supplies.

Especially designed or prepared high-voltage power supplies for ion sources, having all of the following characteristics:

(i) Capable of continuous operation;

(ii) Output voltage of 20,000 V or greater;

(iii) Output current of 1 A or greater; and

(iv) Voltage regulation of better than 0.01% over an 8 hour time period.

(3) Magnet power supplies.

Especially designed or prepared high-power, direct current magnet power supplies having all of the following characteristics:

(i) Capable of continuously producing a current output of 500 A or greater at a voltage of 100 V or greater; and

(ii) A current or voltage regulation better than 0.01% over an 8 hour time period.

[61 FR 35606, July 8, 1996]

APPENDIX I TO PART 110—ILLUSTRATIVE LIST OF REPROCESSING PLANT COMPONENTS UNDER NRC EXPORT LICENSING AUTHORITY

NOTE—Reprocessing irradiated nuclear fuel separates plutonium and uranium from intensely radioactive fission products and other transuranic elements. Different technical processes can accomplish this separation. However, over the years Purex has become the most commonly used and accepted process. Purex involves the dissolution of irradiated nuclear fuel in nitric acid, followed

by separation of the uranium, plutonium, and fission products by solvent extraction using a mixture of tributyl phosphate in an organic diluent.

Purex facilities have process functions similar to each other, including: irradiated fuel element chopping, fuel dissolution, solvent extraction, and process liquor storage. There may also be equipment for thermal denitration of uranium nitrate, conversion of plutonium nitrate to oxide metal, and treatment of fission product waste liquor to a form suitable for long term storage or disposal. However, the specific type and configuration of the equipment performing these functions may differ between Purex facilities for several reasons, including the type and quantity of irradiated nuclear fuel to be reprocessed and the intended disposition of the recovered materials, and the safety and maintenance philosophy incorporated into the design of the facility. A plant of the reprocessing of irradiated fuel elements, includes the equipment and components which normally come in direct contact with and directly control the irradiated fuel and the major nuclear material and fission product processing streams.

(1) Fuel element chopping machines, i.e., remotely operated equipment specially designed or prepared to cut, chop, or shear irradiated nuclear reactor fuel assemblies, bundles, or rods.

(2) Critically safe tanks, i.e., small diameter, annular or slab tanks specially designed or prepared for the dissolution of irradiated nuclear reactor fuel.

(3) Solvent extraction equipment.

Especially designed or prepared solvent extractors such as packed or pulse columns, mixer settlers or centrifugal contactors for use in a plant for the reprocessing of irradiated fuel. Because solvent extractors must be resistant to the corrosive effect of nitric acid, they are normally fabricated to extremely high standards (including special welding and inspection and quality assurance and quality control techniques) out of low carbon stainless steels, titanium, zirconium or other high quality materials.

(4) Chemical holding or storage vessels.

Especially designed or prepared holding or storage vessels for use in a plant for the reprocessing of irradiated fuel. Because holding or storage vessels must be resistant to the corrosive effect of nitric acid, they are normally fabricated of materials such as low carbon stainless steels, titanium or zirconium, or other high quality materials. Holding or storage vessels may be designed for remote operation and maintenance and may have the following features for control of nuclear criticality:

- (i) Walls or internal structures with a boron equivalent of at least 2 percent, or
- (ii) A maximum diameter of 7 inches (17.78 cm) for cylindrical vessels, or

(iii) A maximum width of 3 inches (7.62 cm) for either a slab or annular vessel.

(5) Plutonium nitrate to plutonium oxide conversion systems. Complete systems especially designed or prepared for the conversion of plutonium nitrate to plutonium oxide, in particular adapted so as to avoid criticality and radiation effects and to minimize toxicity hazards.

(6) Plutonium metal production systems. Complete systems especially designed or prepared for the production of plutonium metal, in particular adapted so as to avoid criticality and radiation effects and to minimize toxicity hazards.

(7) Process control instrumentation specially designed or prepared for monitoring or controlling the processing of material in a reprocessing plant.

[55 FR 30451, July 26, 1990, as amended at 58 FR 13005, Mar. 9, 1993. Redesignated at 61 FR 35603, July 8, 1996]

APPENDIX J TO PART 110—ILLUSTRATIVE LIST OF URANIUM CONVERSION PLANT EQUIPMENT AND PLUTONIUM CONVERSION PLANT EQUIPMENT UNDER NRC EXPORT LICENSING AUTHORITY

NOTE—Uranium conversion plants and systems may perform one or more transformations from one uranium chemical species to another, including: conversion of uranium ore concentrates to UO₃, conversion of UO₃ to UO₂, conversion of uranium oxides to UF₄ or UF₆, conversion of UF₄ to UF₆, conversion of UF₆ to UF₄, conversion of UF₄ to uranium metal, and conversion of uranium fluorides to UO₂. Many key equipment items for uranium conversion plants are common to several segments of the chemical process industry, including furnaces, rotary kilns, fluidized bed reactors, flame tower reactors, liquid centrifuges, distillation columns and liquid-liquid extraction columns. However, few of the items are available "off-the-shelf"; most would be prepared according to customer requirements and specifications. Some require special design and construction considerations to address the corrosive properties of the chemicals handled (HF, F₂, CLF₃, and uranium fluorides). In all of the uranium conversion processes, equipment which individually is not especially designed or prepared for uranium conversion can be assembled into systems which are especially designed or prepared for uranium conversion.

(a) Uranium Conversion Plant Equipment.

(1) Especially designed or prepared systems for the conversion of uranium ore concentrates to UO₃.

Conversion of uranium ore concentrates to UO₃ can be performed by first dissolving the ore in nitric acid and extracting purified uranyl nitrate using a solvent such as tributyl

phosphate. Next, the uranyl nitrate is converted to UO₃ either by concentration and denitration or by neutralization with gaseous ammonia to produce ammonium diuranate with subsequent filtering, drying, and calcining.

(2) Especially designed or prepared systems for the conversion of UO₃ to UF₆.

Conversion of UO₃ to UF₆ can be performed directly by fluorination. The process requires a source of fluorine gas or chlorine trifluoride.

(3) Especially Designed or Prepared Systems for the conversion of UO₃ to UO₂.

Conversion of UO₃ to UO₂ can be performed through reduction of UO₃ with cracked ammonia gas or hydrogen.

(4) Especially Designed or Prepared Systems for the conversion of UO₂ to UF₄.

Conversion of UO₂ to UF₄ can be performed by reacting UO₂ with hydrogen fluoride gas (HF) at 300–500°C.

(5) Especially Designed or Prepared Systems for the conversion of UF₄ to UF₆.

Conversion of UF₄ to UF₆ is performed by exothermic reaction with fluorine in a tower reactor. UF₆ is condensed from the hot effluent gases by passing the effluent stream through a cold trap cooled to -10°C. The process requires a source of fluorine gas.

(6) Especially Designed or Prepared Systems for the conversion of UF₄ to U metal.

Conversion of UF₄ to U metal is performed by reduction with magnesium (large batches) or calcium (small batches). The reaction is carried out at temperatures above the melting point of uranium (1130°C).

(7) Especially designed or prepared systems for the conversion of UF₆ to UO₂.

Conversion of UF₆ to UO₂ can be performed by one of three processes. In the first, UF₆ is reduced and hydrolyzed to UO₂ using hydrogen and steam. In the second, UF₆ is hydrolyzed by solution in water, ammonia is added to precipitate ammonium diuranate, and the diuranate is reduced to UO₂ with hydrogen at 820°C. In the third process, gaseous UF₆, CO₂, and NH₃ are combined in water, precipitating ammonium uranyl carbonate. The ammonium uranyl carbonate is combined with steam and hydrogen at 500–600°C to yield UO₂. UF₆ to UO₂ conversion is often performed as the first stage of a fuel fabrication plant.

(8) Especially Designed or Prepared Systems for the conversion of UF₆ to UF₄. Conversion of UF₆ to UF₄ is performed by reduction with hydrogen.

(9) Especially designed or prepared systems for the conversion of UO₂ to UCl₄ as feed for electromagnetic enrichment.

NOTE: Plutonium conversion plants and systems may perform one or more transformations from one plutonium chemical species to another, including: conversion of plutonium nitrate to PuO₂, conversion of PuO₂ to PuF₄ and conversion of PuF₄ to plu-

tonium metal. Plutonium conversion plants are usually associated with reprocessing facilities, but may also be associated with plutonium fuel fabrication facilities. Many of the key equipment items for plutonium conversion plants are common to several segments of the chemical process industry. For example, the types of equipment employed in these processes may include the following items: furnaces, rotary kilns, fluidized bed reactors, flame tower reactors, liquid centrifuges, distillation columns and liquid-liquid extraction columns. Hot cells, glove boxes and remote manipulators may also be required. However, few of the items are available off-the-shelf; most would be prepared according to the requirements and specifications of the customer. Particular care is essential in designing for the special radiological, toxicity and criticality hazards associated with plutonium. In some circumstances, special design and construction considerations are required to address the corrosive properties of some of the chemicals handled (e.g., HF). Finally, it should be noted that, for all plutonium conversion processes, items of equipment which individually are not especially designed or prepared for plutonium conversion can be assembled into systems that are especially designed or prepared for use in plutonium conversion.

(b) Plutonium Conversion Plant Equipment

(1) Especially designed or prepared systems for the conversion of plutonium nitrate to oxide.

The main functions involved in this process are: process feed storage and adjustment, precipitation and solid/liquor separation, calcination, product handling, ventilation, waste management, and process control. The process systems are particularly adapted so as to avoid criticality and radiation effects and to minimize toxicity hazards. In most reprocessing facilities, this process involves the conversion of plutonium nitrate to plutonium dioxide. Other processes can involve the precipitation of plutonium oxalate or plutonium peroxide.

(2) Especially designed or prepared systems for plutonium metal production.

This process usually involves the fluorination of plutonium dioxide, normally with highly corrosive hydrogen fluoride, to produce plutonium fluoride, which is subsequently reduced using high purity calcium metal to produce metallic plutonium and a calcium fluoride slag. The main functions involved in this process are the following: fluorination (e.g., involving equipment fabricated or lined with a precious metal), metal reduction (e.g., employing ceramic crucibles), slag recovery, product handling, ventilation, waste management and process control. The process systems are particularly adapted so as to avoid criticality and radiation effects and to minimize toxicity

hazards. Other processes include the fluorination of plutonium oxalate or plutonium peroxide followed by reduction to metal.

[61 FR 35606, July 8, 1996, as amended at 65 FR 70291, Nov. 22, 2000]

APPENDIX K TO PART 110—ILLUSTRATIVE LIST OF EQUIPMENT AND COMPONENTS UNDER NRC EXPORT LICENSING AUTHORITY FOR USE IN A PLANT FOR THE PRODUCTION OF HEAVY WATER, DEUTERIUM AND DEUTERIUM COMPOUNDS

NOTE: Heavy water can be produced by a variety of processes. However, two processes have proven to be commercially viable: the water-hydrogen sulphide exchange process (GS process) and the ammonia-hydrogen exchange process.

A. The water-hydrogen sulphide exchange process (GS process) is based upon the exchange of hydrogen and deuterium between water and hydrogen sulphide within a series of towers which are operated with the top section cold and the bottom section hot. Water flows down the towers while the hydrogen sulphide gas circulates from the bottom to the top of the towers. A series of perforated trays are used to promote mixing between the gas and the water. Deuterium migrates to the water at low temperatures and to the hydrogen sulphide at high temperatures. Gas or water, enriched in deuterium, is removed from the first stage towers at the junction of the hot and cold sections and the process is repeated in subsequent stage towers. The product of the last stage, water enriched up to 30 percent in deuterium, is sent to a distillation unit to produce reactor grade heavy water; i.e., 99.75 percent deuterium oxide.

B. The ammonia-hydrogen exchange process can extract deuterium from synthesis gas through contact with liquid ammonia in the presence of a catalyst. The synthesis gas is fed into exchange towers and then to an ammonia converter. Inside the towers the gas flows from the bottom to the top while the liquid ammonia flows from the top to the bottom. The deuterium is stripped from the hydrogen in the synthesis gas and concentrated in the ammonia. The ammonia then flows into an ammonia cracker at the bottom of the tower while the gas flows into an ammonia converter at the top. Further enrichment takes place in subsequent stages and reactor-grade heavy water is produced through final distillation. The synthesis gas feed can be provided by an ammonia plant that can be constructed in association with a heavy water ammonia-hydrogen exchange plant. The ammonia-hydrogen exchange process can also use ordinary water as a feed source of deuterium.

C.1. Much of the key equipment for heavy water production plants using either the water-hydrogen sulphide exchange process (GS process) or the ammonia-hydrogen exchange process are common to several segments of the chemical and petroleum industries; particularly in small plants using the GS process. However, few items are available "off-the-shelf." Both processes require the handling of large quantities of flammable, corrosive and toxic fluids at elevated pressures. Thus, in establishing the design and operating standards for plants and equipment using these processes, careful attention to materials selection and specifications is required to ensure long service life with high safety and reliability factors. The choice is primarily a function of economics and need. Most equipment, therefore, is prepared to customer requirements.

In both processes, equipment which individually is not especially designed or prepared for heavy water production can be assembled into especially designed or prepared systems for producing heavy water. Examples of such systems are the catalyst production system used in the ammonia-hydrogen exchange process and the water distillation systems used for the final concentration of heavy water to reactor-grade in either process.

C.2. Equipment especially designed or prepared for the production of heavy water utilizing either the water-hydrogen sulphide exchange process or the ammonia-hydrogen exchange process:

(i) Water-hydrogen Sulphide Exchange Towers

Exchange towers fabricated from carbon steel (such as ASTM A516) with diameters of 6 m (20 ft) to 9 m (30 ft), capable of operating at pressures greater than or equal to 2 MPa (300 psi) and with a corrosion allowance of 6mm or greater.

(ii) Blowers and Compressors

Single stage, low head (i.e., 0.2 MPa or 30 psi) centrifugal blowers or compressors for hydrogen-sulphide gas circulation (i.e., gas containing more than 70 percent H₂ S). The blowers or compressors have a throughput capacity greater than or equal to 56 m³/second (120,000 SCFM) while operating at pressures greater than or equal to 1.8 MPa (260 psi) suction and have seals designed for wet H₂ S service.

(iii) Ammonia-Hydrogen Exchange Towers

Ammonia-hydrogen exchange towers greater than or equal to 35 m (114.3 ft) in height with diameters of 1.5 m (4.9 ft) to 2.5 m (8.2 ft) capable of operating at pressures greater than 15 MPa (2225 psi). The towers have at least one flanged, axial opening of the same diameter as the cylindrical part through which the tower internals can be inserted or withdrawn.

(iv) Tower Internals and Stage Pumps Used in the Ammonia-hydrogen Exchange Process.

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Tower internals include especially designed stage contactors which promote intimate gas/liquid contact. Stage pumps include especially designed submersible pumps for circulation of liquid ammonia within a contacting stage internal to the stage towers.

(v) Ammonia Crackers Utilizing the Ammonia-hydrogen Exchange Process.

Ammonia crackers with operating pressures greater than or equal to 3 MPa (450 psi).

(vi) Infrared Absorption Analyzers

Infrared absorption analyzers capable of "on-line" hydrogen/deuterium ratio analysis where deuterium concentrations are equal to or greater than 90 percent.

(vii) Catalytic Burners Used in the Ammonia-hydrogen Exchange Process.

Catalytic burners for the conversion of enriched deuterium gas into heavy water.

(viii) Complete Heavy Water Upgrade Systems or Columns.

Complete heavy water upgrade systems or columns especially designed or prepared for the upgrade of heavy water to reactor-grade deuterium concentration. These systems, which usually employ water distillation to separate heavy water from light water, are especially designed or prepared to produce reactor-grade heavy water (i.e., typically 99.75% deuterium oxide) from heavy water feedstock of lesser concentration.

[58 FR 13005, Mar. 9, 1993. Redesignated at 61 FR 35603, July 8, 1996; 65 FR 70292, Nov. 22, 2000]

APPENDIX L TO PART 110—ILLUSTRATIVE LIST OF BYPRODUCT MATERIALS UNDER NRC EXPORT/IMPORT LICENSING AUTHORITY

Actinium 225 (Ac 225)	Bromine 82 (Br 82)
Actinium 227 (Ac 227)	Cadmium 109 (Cd 109)
Actinium 228 (Ac 228)	Cadmium 113 (Cd 113)
Americium 241 (Am 241)	Cadmium 115m (Cd 115m)
Americium 242m (Am 242m)	Cadmium 115 (Cd 115)
Americium 242 (Am 242)	Calcium 45 (Ca 45)
Americium 243 (Am 243)	Calcium 47 (Ca 47)
	Californium 248 (Cf 248)
	Californium 249 (Cf 249)
Antimony 124 (Sb 124)	Californium 250 (Cf 250)
Antimony 125 (Sb 125)	Californium 251 (Cf 251)
Antimony 126 (Sb 126)	Californium 252 (Cf 252)
Arsenic 73 (As 73)	Californium 253 (Cf 253)
Arsenic 74 (As 74)	Californium 254 (Cf 254)
Arsenic 76 (As 76)	Carbon 14 (C 14)
Arsenic 77 (As 77)	
Barium 131 (Ba 131)	
Barium 133 (Ba 133)	
Barium 140 (Ba 140)	
Bismuth 207 (Bi 207)	
Bismuth 210 (Bi 210)	

Cerium 141 (Ce 141)	Indium 114m (In 114m)
Cerium 143 (Ce 143)	Indium 115m (In 115m)
Cerium 144 (Ce 144)	Indium 115 (In 115)
Cesium 131 (Cs 131)	Iodine 125 (I 125)
Cesium 134m (Cs 134m)	Iodine 126 (I 126)
Cesium 134 (Cs 134)	Iodine 129 (I 129)
Cesium 135 (Cs 135)	Iodine 131 (I 131)
Cesium 136 (Cs 136)	Iodine 132 (I 132)
Cesium 137 (Cs 137)	Iodine 133 (I 133)
Chlorine 36 (Cl 36)	Iodine 134 (I 134)
Chlorine 38 (Cl 38)	Iodine 135 (I 135)
Chromium 51 (Cr 51)	Iridium 192 (Ir 192)
Cobalt 58m (Co 58m)	Iridium 194 (Ir 194)
Cobalt 58 (Co 58)	Iron 55 (Fe 55)
Cobalt 60 (Co 60)	Iron 59 (Fe 59)
Copper 64 (Cu 64)	Krypton 85 (Kr 85)
Curium 240 (Cm 240)	Krypton 87 (Kr 87)
Curium 241 (Cm 241)	Lanthanum 140 (La 140)
Curium 242 (Cm 242)	Lead 210 (Pb 210)
Curium 243 (Cm 243)	Lutetium 177 (Lu 177)
Curium 244 (Cm 244)	Manganese 52 (Mn 52)
Curium 245 (Cm 245)	Manganese 54 (Mn 54)
Curium 247 (Cm 247)	Manganese 56 (Mn 56)
Dysprosium 165 (Dy 165)	Mendelevium 258 (Md 258)
Dysprosium 166 (Dy 166)	Mercury 197m (Hg 197m)
Einsteinium 252 (Es 252)	Mercury 197 (Hg 197)
Einsteinium 253 (Es 253)	Mercury 203 (Hg 203)
Einsteinium 254 (Es 254)	Molybdenum 99 (Mo 99)
Einsteinium 255 (Es 255)	Neodymium 147 (Nd 147)
Erbium 169 (Er 169)	Neodymium 149 (Nd 149)
Erbium 171 (Er 171)	Neptunium 235 (Np 235)
Europium 152 (Eu 152)	Neptunium 237 (Np 237)
Europium 152 9.2 h (Eu 152 9.2 h)	Nickel 59 (Ni 59)
Europium 152 13 yr (Eu 152 13 yr)	Nickel 63 (Ni 63)
Europium 154 (Eu 154)	Nickel 65 (Ni 65)
Europium 155 (Eu 155)	Niobium 93m (Nb 93m)
Fermium 257 (Fm 257)	Niobium 94 (Nb 94)
Fluorine 18 (F 18)	Niobium 95 (Nb 95)
Gadolinium 148 (Gd 148)	Niobium 97 (Nb 97)
Gadolinium 153 (Gd 153)	Osmium 185 (Os 185)
Gadolinium 159 (Gd 159)	Osmium 191m (Os 191m)
Gallium 72 (Ga 72)	Osmium 191 (Os 191)
Germanium 68 (Ge 68)	Osmium 193 (Os 193)
Germanium 71 (Ge 71)	Palladium 103 (Pd 103)
Gold 198 (Au 198)	Palladium 109 (Pd 109)
Gold 199 (Au 199)	Phosphorus 32 (P 32)
Hafnium 172 (Hf 172)	Phosphorus 33 (P 33)
Hafnium 181 (Hf 181)	Platinum 191 (Pt 191)
Holmium 166m (Ho 166m)	Platinum 193m (Pt 193m)
Holmium 166 (Ho 166)	Platinum 193 (Pt 193)
Hydrogen 3 (H 3)	
Indium 113m (In 113m)	

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Platinum 197m (Pt 197m)	Ruthenium 105 (Ru 105)	Technetium 97 (Tc 97)	Tin 125 (Sn 125)
Platinum 197 (Pt 197)	Ruthenium 106 (Ru 106)	Technetium 99m (Tc 99m)	Tin 126 (Sn 126)
Polonium 208 (Po 208)	Samarium 151 (Sm 151)	Technetium 99 (Tc 99)	Titanium 44 (Ti 44)
Polonium 209 (Po 209)	Samarium 153 (Sm 153)	Tellurium 125m (Te 125m)	Tritium (H3)
Polonium 210 (Po 210)	Scandium 46 (Sc 46)	Tellurium 127m (Te 127m)	Tungsten 181 (W 181)
Potassium 42 (K 42)	Scandium 47 (Sc 47)	Tellurium 127 (Te 127)	Tungsten 185 (W 185)
Praseodymium 142 (Pr 142)	Scandium 48 (Sc 48)	Tellurium 129m (Te 129m)	Tungsten 187 (W 187)
Praseodymium 143 (Pr 143)	Selenium 75 (Se 75)	Tellurium 129 (Te 129)	Vanadium 48 (V 48)
Promethium 145 (Pm 145)	Silicon 31 (Si 31)	Tellurium 131m (Te 131m)	Xenon 131m (Xe 131m)
Promethium 147 (Pm 147)	Silver 105 (Ag 105)	Tellurium 132 (Te 132)	Xenon 133 (Xe 133)
Promethium 149 (Pm 149)	Silver 110m (Ag 110m)	Terbium 160 (Tb 160)	Xenon 135 (Xe 135)
Radium 223 (Ra 223)	Silver 111 (Ag 111)	Thallium 200 (Tl 200)	Ytterbium 175 (Yb 175)
Rhenium 186 (Re 186)	Sodium 22 (Na 22)	Thallium 201 (Tl 201)	Yttrium 90 (Y 90)
Rhenium 188 (Re 188)	Sodium 24 (Na 24)	Thallium 202 (Tl 202)	Yttrium 91 (Y 91)
Rhodium 103m (Rh 103m)	Strontium 85 (Sr 85)	Thallium 204 (Tl 204)	Yttrium 92 (Y 92)
Rhodium 105 (Rh 105)	Strontium 89 (Sr 89)	Thulium 170 (Tm 170)	Yttrium 93 (Y 93)
Rubidium 86 (Rb 86)	Strontium 90 (Sr 90)	Thulium 171 (Tm 171)	Zinc 65 (Zn 65)
Rubidium 87 (Rb 87)	Strontium 91 (Sr 91)	Tin 113 (Sn 113)	Zinc 69m (Zn 69m)
Ruthenium 97 (Ru 97)	Strontium 92 (Sr 92)	Tin 123 (Sn 123)	Zinc 69 (Zn 69)
Ruthenium 103 (Ru 103)	Sulphur 35 (S 35)		Zirconium 93 (Zr 93)
	Tantalum 182 (Ta 182)		Zirconium 95 (Zr 95)
	Technetium 96 (Tc 96)		Zirconium 97 (Zr 97)
	Technetium 97m (Tc 97m)		

[58 FR 13005, Mar. 9, 1993, as amended at 59 FR 48998, Sept. 26, 1994. Redesignated and amended at 61 FR 35603, 35607, July 8, 1996; 65 FR 70292, Nov. 22, 2000]

APPENDIX M TO PART 110—CATEGORIZATION OF NUCLEAR MATERIAL ^D

[From IAEA INFCIRC/225, Rev. 1]

Material	Form	Category		
		I	II	III ^e
1. Plutonium ^a	Unirradiated ^b	2 kg or more	Less than 2 kg but more than 500 g.	500 g or less.
2. Uranium-235 ^c	Unirradiated: ^b			
	Uranium enriched to 20 pct U ²³⁵ or more.	5 kg or more	Less than 5 kg but more than 1 kg.	1 kg or less.
	Uranium enriched to 10 pct U ²³⁵ but less than 20 pct.	10 kg or more	Less than 10 kg.
	Uranium enriched above natural, but less than 10 pct U ²³⁵	10 kg or more.
3. Uranium-233	Unirradiated ^b	2 kg or more	Less than 2 kg but more than 500 g.	500 g or less.

^a All plutonium except that with isotopic concentration exceeding 80 pct in plutonium-238.

^b Material not irradiated in a reactor or material irradiated in a reactor but with a radiation level equal to or less than 100 rd/h at 1 m unshielded.

^c Natural uranium, depleted uranium, thorium and quantities of uranium enriched to less than 10% not falling into Category III should be protected in accordance with prudent management practice.

^d Irradiated fuel should be protected as category I, II, or III nuclear material depending on the category of the fresh fuel. However, fuel which by virtue of its original fissile material content is included as category I or II before irradiation should only be reduced one category level, while the radiation level from the fuel exceeds 100 rd/h at 1 m unshielded.

^e Physical security determinations will not be required for 15 g or less of plutonium, uranium-233 or high-enriched uranium, or for 1 kg or less of uranium with an enrichment between 10 and 20 pct in uranium-235.

(Sec. 161, as amended, Pub. L. 83-703, 68 Stat. 948 (42 U.S.C. 2201); sec. 201, as amended, Pub. L. 93-438, 88 Stat. 1243 (42 U.S.C. 5841))

[43 FR 21641, May 19, 1978. Redesignated and amended at 49 FR 47204, Dec. 3, 1984. Further redesignated at 55 FR 30450, July 26, 1990; 58 FR 13005, Mar. 9, 1993; 61 FR 35603, July 8, 1996]

APPENDIX N TO PART 110—ILLUSTRATIVE LIST OF LITHIUM ISOTOPE SEPARATION FACILITIES, PLANTS AND EQUIPMENT UNDER NRC'S EXPORT LICENSING AUTHORITY

a. Facilities or plants for the separation of lithium isotopes.

b. Equipment for the separation of lithium isotopes, such as:

- (1) Packed liquid-liquid exchange columns especially designed for lithium amalgams;
- (2) Mercury and/or lithium amalgam pumps;
- (3) Lithium amalgam electrolysis cells;
- (4) Evaporators for concentrated lithium hydroxide solution.

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APPENDIX O TO PART 110—ILLUSTRATIVE LIST OF FUEL ELEMENT FABRICATION PLANT EQUIPMENT AND COMPONENTS UNDER NRC'S EXPORT LICENSING AUTHORITY

NOTE: Nuclear fuel elements are manufactured from source or special nuclear material. For oxide fuels, the most common type of fuel equipment for pressing pellets, sintering, grinding and grading will be present. Mixed oxide fuels are handled in glove boxes (or equivalent containment) until they are sealed in the cladding. In all cases the fuel is hermetically sealed inside a suitable cladding which is designed to be the primary envelope encasing the fuel so as to provide suitable performance and safety during reactor operation. Also, in all cases precise control of processes, procedures and equipment to extremely high standards is necessary in order to ensure predictable and safe fuel performance.

(a) Items that are considered especially designed or prepared for the fabrication of fuel elements include equipment that:

- (1) Normally comes in direct contact with, or directly processes or controls, the production flow of nuclear material;
- (2) Seals the nuclear material within the cladding;
- (3) Checks the integrity of the cladding or the seal; and
- (4) Checks the finished treatment of the sealed fuel.

(b) This equipment or systems of equipment may include, for example:

- (1) Fully automatic pellet inspection stations especially designed or prepared for checking final dimensions and surface defects of fuel pellets;
- (2) Automatic welding machines especially designed or prepared for welding end caps onto the fuel pins (or rods);
- (3) Automatic test and inspection stations especially designed or prepared for checking

the integrity of completed fuel pins (or rods). This item typically includes equipment for:

- (i) X-ray examination of pin (or rod) end cap welds;
- (ii) Helium leak detection from pressurized pins (or rods); and
- (iii) Gamma-ray scanning of the pins (or rods) to check for correct loading of the fuel pellets inside.

[65 FR 70292, Nov. 22, 2000]

PART 140—FINANCIAL PROTECTION REQUIREMENTS AND INDEMNITY AGREEMENTS

Subpart A—General Provisions

Sec.

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- 140.2 Scope.
- 140.3 Definitions.
- 140.4 Interpretations.
- 140.5 Communications.
- 140.6 Reports.
- 140.7 Fees.
- 140.8 Specific exemptions.
- 140.9 Modification of indemnity agreements.
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- 140.10 Scope.
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- 140.14 Types of financial protection.
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- 140.18 Special provisions applicable to licensees furnishing financial protection in whole or in part in the form of adequate resources.
- 140.19 Failure by licensees to maintain financial protection.
- 140.20 Indemnity agreements and liens.